NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Coal, Train Transport

Reference Flow: 1 kg of Cargo

Brief Description: Transport of an unspecified type of prepared coal via train to the energy conversion facility. Assumes backhaul and front haul have the same energy intensity. Includes diesel consumption and fugitive dust emissions.

Section I: Meta Data

Geographical Coverage: US **Region:** N/A

Year Data Best Represents: 2015

Process Type: Transport Process (TP)

Process Scope: Gate-to-Gate Process (GG)

Allocation Applied: No

Completeness: All Relevant Flows Recorded

Flows Aggregated in Data Set:

☒ Process ☒ Energy Use ☐ Energy P&D ☐ Material P&D

Relevant Output Flows Included in Data Set:

Releases to Air:	☒ Greenhouse Gases	☒ Criteria Air Pollutants	☒ Other
Releases to Water:	☐ Inorganic Emissions	☐ Organic Emissions	☐ Other
Water Usage:	☐ Water Consumption	☐ Water Demand (throughput)	
Releases to Soil:	☐ Inorganic Releases	☐ Organic Releases	☐ Other

Adjustable Process Parameters:

Distance	*Round trip distance, in km*
Cargo Out	*Amount of cargo at unloading, in kg*
Btu per liter of diesel	*Energy content of diesel, in Btu/liter of diesel*
Energy per kg-km	*Power demand per kilogram carried per kilometer of transport, in Btu/kg-km*
Sulfur Content of Diesel	*Sulphur content of diesel, in kg S/kg diesel*

Tracked Input Flows:

Diesel [Crude oil products]	*Diesel from crude oil, for consumption during cargo transport*
Cargo [Other]	*Unspecified type of prepared coal for transport*

Tracked Output Flows:

Cargo [Other]	*Unspecified type of prepared coal received, reference flow*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage2_O_Coal_Train_Transport_2010.01.xls*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

The scope of this unit process covers the transportation of a unit train loaded with an unspecified type of prepared coal from the boundary of Life Cycle (LC) Stage #1 at the mine site, to the energy conversion facility for the commencement of LC Stage #3 (e.g., the conversion of the coal into energy), as well as the empty return trip back to the mine. This unit process encompasses all of LC Stage #2. This unit process is based on the reference flow of 1 kg of an unspecified type of coal being delivered to the energy conversion facility, as shown in **Figure 1**. Considered are the consumption of diesel and the resulting emissions from diesel combustion, as well as the fugitive coal dust particles that may be lost during transport.

Boundary and Description

Operational data for the train is compiled from many sources, to create an emissions profile for criteria air pollutants and other pollutants of interest. The unit process is designed such that the type of coal being transported and location of transport (inside the U.S.) are irrelevant. This unit process assumes that the unspecified prepared coal is loaded into the train during a previous unit process. This unit process transports the unspecified prepared coal from an unspecified type of coal mine to an unspecified type of energy conversion facility.

Figure 1 provides an overview of the boundary of this unit process. As shown, upstream emissions associated with the production diesel fuel and processed coal are accounted for outside of the boundary of this unit process.

The user has the ability to vary certain parameters to tailor the dataset to fit the diesel production profile used. The parameters listed in the Adjustable Process Parameter

section are the primary differentiators between diesel analyses. Three of the five adjustable parameters help to determine the amount of diesel needed for transportation. These include the energy content of the diesel, the power demand of the train, and the roundtrip transport distance. The default values for these parameters are, respectively, 36,641 Btu/liter, 225 Btu/kg-km, and 100 km. The fourth adjustable parameter is the sulfur content of the diesel fuel, with a default value of 0.000015 kg S/kg diesel. The sulfur content of the fuel is important due to the effect on the resulting air emissions. The fifth parameter, the quantity for the flow of the cargo, has been added to enable calculation of fugitive dust losses. These parameters may be varied based on updated information, or the specific values needed for a given investigation.

All emission factors for diesel combustion are provided in **Table 1**. It is assumed that the train will be operating around or after the year 2015, and will therefore be in compliance with the US Environmental Protection Agency's (EPA) Tier 4 emissions standards, which will become effective in 2015. The Tier 4 standards include regulations for NO_X, PM, VOCs, and CO (US Federal Register 2008). Emission factors for CO_2, CH_4, and N_2O were taken from the documentation for the US Energy Information Administration's (EIA) form for the voluntary reporting of greenhouse gases (DOE 2006). Stiochiometric conversions determined the SO_2 emissions from diesel combustion. It was assumed that all sulfur contained in the diesel fuel would be converted to SO_2.

The fugitive dust emissions were based on an Australian coal mine transport study (Connell-Hatch 2008). The amount of mercury released as a result of the combustion of diesel was based on data from a study examining gasoline and diesel fuel combustion in the San Francisco Bay area of California (Conaway *et al*. 2005). An emission factor for ammonia from diesel combustion from mobile sources was obtained from a report that developed emission factors for various sources of ammonia (Battye *et al*. 1994). Any calculations needed to convert or adjust the data to be applicable in NETL studies are supplied in the associated DS mentioned above.

Figure 1. Unit Process Flow Diagram

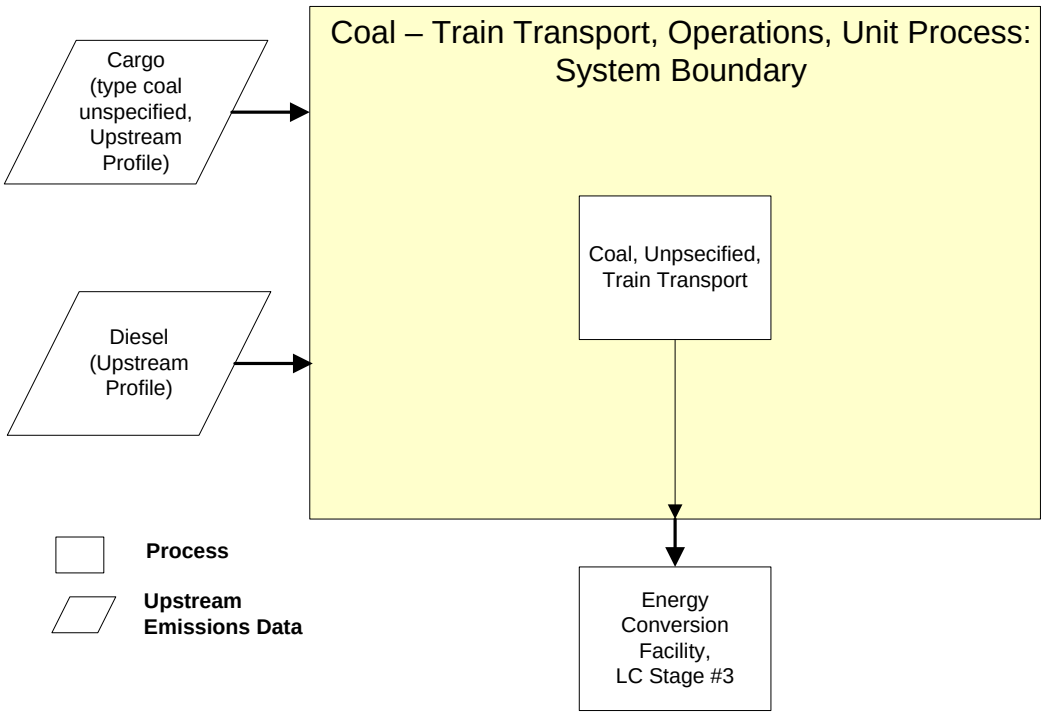

Table 1. Emission Factors for Train Transport

Emission	Value	Units (per kg cargo transported)	Reference
Carbon Dioxide	1.3716E-02 (3.0239E-02)	kg (lbs)	DOE 2006
Methane	4.9052E-04 (1.0814E-03)	kg (lbs)	DOE 2006
Nitrous Oxide	1.5942E-04 (3.5146E-04)	kg (lbs)	DOE 2006
Sulphur Oxide	2.8682E-07 (6.3233E-07)	kg (lbs)	NETL Engineering Calculation
Nitrogen Oxides	7.9709E-04 (1.7573E-03)	kg (lbs)	US Federal Register 2008
Particulate Matter, unspecified	1.8517E-05 (4.0822E-05)	kg (lbs)	US Federal Register 2008, Connell-Hatch 2008
VOCs, unspecified	8.5841E-05 (1.8925E-04)	kg (lbs)	US Federal Register 2008
Carbon Monoxide	9.1972E-04 (2.0276E-03)	kg (lbs)	US Federal Register 2008
Mercury (+II)	8.0844E-20 (1.7823E-19)	kg (lbs)	Conaway *et al*. 2005

Ammonia	6.7446E-08 (1.4869E-07)	kg (lbs)	Battye *et al*. 1994

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)
Inputs		
Unspecified Coal	**1.000000122**	**kg**
Diesel [Crude oil products]	**6.1315E-4**	**L**
Outputs		
Unspecified Coal	1.00E+00	kg
Carbon dioxide [Inorganic emissions to air]	1.3716E-02	kg
Methane [Organic emissions to air (group VOC)]	4.9052E-04	kg
Nitrous oxide (laughing gas) [Inorganic emissions to air]	1.5942E-04	kg
Sulphur oxide [Inorganic emissions to air]	2.8682E-07	kg
Nitrogen oxides [Inorganic emissions to air]	7.9709E-04	kg
Particulate Matter, unspecified [Other emissions to air]	1.8517E-05	kg
VOC (unspecified) [Organic emissions to air (group VOC)]	8.5841E-05	kg
Carbon monoxide [Inorganic emissions to air]	9.1972E-04	kg
Mercury (+II) [Heavy metals to air]	8.0844E-20	kg
Ammonia [Inorganic emissions to air]	6.7446E-08	kg

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows.

Embedded Unit Processes

None.

References

Battye *et al*. 1994 — Battye, R., Battye, W., Overcash, C., Fudge, S. 1994. *Development and Selection of Ammonia Emissions Factors, Final Report*. U.S. Environmental Protection Agency, Washington, D.C. http://www.epa.gov/ttn/chief/old/efdocs/ammonia.pdf (Accessed December 16, 2009).

Conaway *et al*. 2005 — Conaway, C.H., Mason, R.P., Steding, D.J., Flegal, A.R. 2005. "Estimate of mercury emission from gasoline and diesel consumption, San Francisco Bay area, California." *Atmospheric Environment* 39:101-105. http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6VH3-4DPC3KY-2-1&_cdi=6055&_user=2638189&_orig=search&_cover

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Connell-Hatch 2008	Connell Hatch. 2008. *Final Report, Environmental Evaluation of Fugitive Coal Dust Emissions from Coal Trains: Goonyella, Blackwater and Moura Coal Rail Systems, Queensland Rail Limited.* Reference H327578-N00-EE00.00. Connell Hatch, Queensland, Australia. March 1, 2008.
DOE 2006	US DOE. 2006. *Form EIA-1605 Long Form for Voluntary Reporting of Greenhouse Gases: Instructions. Appendix H: Fuel Emissions Factors.* OMB No. 1905-0194. U.S. Department of Energy. March, 2006. http://www.eia.doe.gov/oiaf/1605/excel/Fuel%20Emission%20Factors.xls (Accessed December 16, 2009).
US Federal Register 2008	National Archives and Records Administration. 2008. "Part IV: Environmental Protection Agency: 40 CFR Parts 9, 85, et al. Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression-Ignition Engines Less Than 30 Liters per Cylinder, Republication, Final Rule." National Records and Archives Administration, Washington, D.C. *Federal Register* 73(126). June 30, 2008. http://www.epa.gov/fedrgstr/EPA-AIR/2008/June/Day-30/a7999a.pdf (Accessed December 16, 2009).

Section III: Document Control Information

Date Created: January 15, 2010

Point of Contact: Timothy Skone (NETL), Timothy.Skone@NETL.DOE.GOV

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